IN THE CLAIMS

Claims

What is claimed is:

1. (Currently Amended) An apparatus for measuring the gas volume fraction process flow flowing within a pipe, the apparatus comprising:

at least two sensors ~~one sensor for providing~~ that provide a sound measurement signal indicative of ~~the speed of~~ sound waves propagating in the process flow flowing within the pipe; and

a processor ~~for determining~~ that determines the slope of an acoustic ridge in the k-ω plane, in response to the sound measurement signals, to provide a sound speed signal indicative of the speed of sound propagating through the process flow, and that determines the gas volume fraction of the flow, in response to the ~~sound measurement~~ sound speed signal.

2. (Currently Amended) The apparatus of claim 1, wherein the at least ~~one sensor includes~~ two sensors include at least two pressure strain sensors at different axial locations along the pipe, each of the pressure strain sensors providing a respective ~~pressure~~ strain signal indicative of ~~a~~ an acoustic pressure disturbance within the pipe at a corresponding axial position.

3. (Original) The apparatus of claim 1, wherein the process flow is one of a liquid having entrained gas, a mixture having entrained gas, and a slurry having entrained gas.

4. (Canceled)

5. (Currently Amended) A method of measuring the gas volume fraction process flow flowing within a pipe, the method comprising:

measuring the ~~speed of~~ sound waves propagating in the process flow flowing within the pipe to provide a sound measurement signal; ~~and~~

determining the slope of an acoustic ridge in the k-ω plane, in response to the sound measurement signals, to provide a sound speed signal indicative of the speed of sound propagating through the process flow, and

determining the gas volume fraction of the process flow, in response to the ~~measured speed of sound~~ sound speed signal.

6. (Currently Amended) The method of claim 5 further comprises providing at least ~~one sensor for measuring~~ two sensors that measure the sound waves ~~the speed of sound~~ propagating in the process flow. ~~within the pipe~~

7. (Currently Amended) The method of claim6, wherein the ~~at least one sensor includes~~ at least two ~~pressure~~ strain sensors are at different axial locations along the pipe, each of the ~~pressure~~ strain sensors providing a respective ~~pressure~~ strain signal indicative of ~~a~~ an acoustic pressure disturbance within the pipe at a corresponding axial position.

8. (Currently Amended) The method of claim ~~1~~ 5, wherein the process flow is one of a liquid having entrained gas, a mixture having entrained gas, and a slurry having entrained gas.

9. (Canceled)

10. (New) The apparatus of claim 2, wherein the strain sensors are pressure sensors.

11. (New) The apparatus of claim 1, wherein the processor determines the gas volume fraction using at least one of the pressure and temperature of the process flow.

12. (New) The apparatus of claim 11, wherein the apparatus further includes at least one of a pressure sensor and temperature sensor to respective determine the pressure and temperature of the process flow.

13. (New) The apparatus of claim 1, wherein the sound waves are one dimensional acoustic waves.

14. (New) The apparatus of claim 1, wherein the at least two sensors include 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16 sensors.

15. (New) The apparatus of claim 1, further includes an acoustic source for generating souond waves within the process flow.

16. (New) The apparatus of claim 1, wherein the sound wave is a passive noise.

17. (New) The apparatus of claim 1, wherein the gas volume fraction is determined using the following formula:

Gas Voulume Fraction = -B+sqrt(B^2-4*A*C))/(2*A)

wherein A=1+rg/rl*(K_{eff}/P-1)-K_{eff}/P, B=K_{eff}/P-2+rg/rl; C=1-K_{eff}/rl*a_{meas}^2; Rg = gas density, rl = liquid density, K_{eff} = effective K (modulus of the liquid and pipewall), P= pressure, and a_{meas} = measured speed of sound.

18. (New) The method of claim 5, wherein the processor determines the gas volume fraction using at least one of the pressure and temperature of the process flow.

19. (New) The method of claim 18, wherein the apparatus further includes at least one of a pressure sensor and temperature sensor to respective determine the pressure and temperature of the process flow.

20. (New) The method of claim 5, wherein the at least two sensors include 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16 sensors.

21. (New) The method of claim 5, further includes an acoustic source for generating sound waves within the process flow.

22. (New) The method of claim 5, wherein the gas volume fraction is determined using the following formula:

Gas Voulume Fraction = -B+sqrt(B^2-4*A*C))/(2*A)

wherein A=1+rg/rl*(K_{eff}/P-1)-K_{eff}/P, B=K_{eff}/P-2+rg/rl; C=1-K_{eff}/rl*a_{meas}^2; Rg = gas density, rl = liquid density, K_{eff} = effective K (modulus of the liquid and pipewall), P= pressure, and a_{meas} = measured speed of sound.